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BRIEFER ARTICLES

THE EPIDERMAL CHARACTERS OF FRENELOPSIS RAMOSISSIMA

(WITH TWO FIGURES)

The genus *Frenelopsis* was founded by SCHENCK in 1869[1] upon abundant material from the Wernsdorferschichten (Lower Cretaceous), and named from its resemblance to the modern genus *Frenela*. *Thuites Hoheneggeri* of ETTINGSHAUSEN was the type and only species. This was, he says, the most abundant fossil in those beds in which it occurs, and it received a careful and elaborate treatment at his hands. This species has subsequently been recognized in the Kome beds of Greenland, the Trinity beds of the Texas region, the Raritan and Magothy formations of New Jersey, and the Turonian of Bagnols, France. In 1880 HOSIUS and VAN DER MARCK described a rather illy defined species, *Frenelopsis Königii*, from the Senonian of Westphalia,[2] and the next year HEER[3] described an additional species, *F. occidentalis*, from Portugal, which SAPORTA has shown[4] ranges from the Urgonian of Cercal, through the Albian of Nazareth, into the Cenomanian of Alcantara and Padrao. The latter author also describes an additional species, *F. leptoclada*,[5] which is confined to the Lower Cretaceous of Portugal (Neocomian-Aptian).

In 1889 VELENOVSKY described the Bohemian form *F. bohemica* from the Cenomanian of that country (*op. cit.*), and the next year FONTAINE described the two species *F. ramosissima* and *F. parceramosa* from the Potomac group of Virginia, the same author three years later founding a third species, *F. varians*, upon material from the Trinity group of Texas. NEWBERRY in 1896 described a ninth species, *F. gracilis*,[6] which is a very abundant Upper Cretaceous type, and which has been recently shown by HOLLICK and JEFFREY to be unrelated to *Frenelopsis*.[7]

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[1] Palaeontographica **19**:13. 1869.

[2] *Ibid.* **26**:132, 181. *pl. 37, fig. 148.* 1880.

[3] Cont. Foss. Fl. Port. 1881:21. *pl. 12, figs. 3b, 4–7.*

[4] Fl. Foss. Port. 1894:139, 199, 214. *pl. 26, fig. 16; pl. 36, figs. 1, 2; pl. 38, figs. 2, 3; pl. 39, fig. 20.*

[5] *Ibid.* 109, 113. *pl. 19, fig. 18; pl. 21, figs. 9–11.*

[6] Fl. Amboy Clays 1896:59. *pl. 12, figs. 1–3a.*

Although fruiting specimens have not been found, the position of the genus in the Cupressineae is not disputed at the present time, although at one time HEER argued for an affinity with *Ephedra*. The genus may be defined as follows:

> Shrubs or trees with cylindrical, jointed, monopodial stems and branches, the latter of which may be alternate, apparently in a single plane, or whorl, often of large size, stems up to 5 cm. in diameter having been found in the Virginia area. Leaves much reduced, somewhat variable in outline, in general triangular with a broad base and an acute apex, squamiform, appressed, one to four at the nodes, decussate. Internodes variable in length, but longer in the apparently annual shoots, which were more or less deciduous and functioned as leaves, since the fine longitudinal striae with which their surface is ornamented turn out to be rows of stomata in certain of the species which have been examined microscopically.

It is for the purpose of describing the latter characters of this interesting American Lower Cretaceous species that the following brief note is published.

Frenelopsis ramosissima ranges from the bottom to the top of the Lower Cretaceous in the Maryland-Virginia region to which it is thus far confined. It is by far the most abundant form at the celebrated plant locality of Fredericksburg, Va. The coarse arkosic sandy clays of this age are sometimes packed with the remains of this species, with its crowded twigs and short internodes generally completely flattened, and with all of the tissues gone except the epidermis, which must have been very tough and coriaceous in life, since the preservation of these forms was largely due to its resistant nature. The cuticle of the type of the genus, *F. Hoheneggeri*, was studied by ZEILLER and described in 1882,[8] and six years later VELENOVSKY described[9] the epidermal features of *F. bohemica*. The stomata in these species were found to consist of usually four cells, although sometimes five or even six were present. These guard cells are symmetrically arranged, the opening between them being approximately in the form of a narrow-rayed star. According to the former author, they ally these forms with the existing species of *Cal-*

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[7] Mem. N.Y. Bot. Gard. **23**:6. 1909.

[8] Obs. sur quelques cuticules fossiles. Ann. Sci. Nat. Bot. VI. **13**:231. *pl. 11.* 1882; Eléments de paléobotanique 274. *fig. 196.* 1900.

[9] Ueber einige neue Pflanzenformen der böhmischen Kreideformation. Sitz. K. Böhm. Gesell. Wiss. Prag 1888:590. *figs. 1–3, 10.*

litris and *Libocedrus*, and effectually disprove HEER'S contention that this curious genus is a member of the Gnetales allied to *Ephedra*.

In *F. ramosissima* we find a very similar arrangement to that described in the two species just mentioned. The epidermal cells are very small, the largest not exceeding 0.025 mm. in diameter, and the average being about half this size. They are roughly rectangular in shape and have very thick walls. Their most curious feature, one not observed in any other species of this genus, is the presence of minute, usually curved, spinelike outgrowths of large numbers of the epidermal cells. These protuberances vary in prominence from blunt papillae of various heights to pointed spines 0.025 mm. in length. These are not present on all of the epidermal cells, and some preparations of the epidermis are apparently entirely smooth. Fig. 1 shows a characteristic bit of the epidermis dotted with these spines. For the camera lucida drawings from which this figure was made I am indebted to Dr. FREDERICK H. BLODGETT, a former student of the Johns Hopkins University. Some of the spines, probably all of them, have a central cavity opening into the interior of the epidermal cell, which they surmount, as is shown in

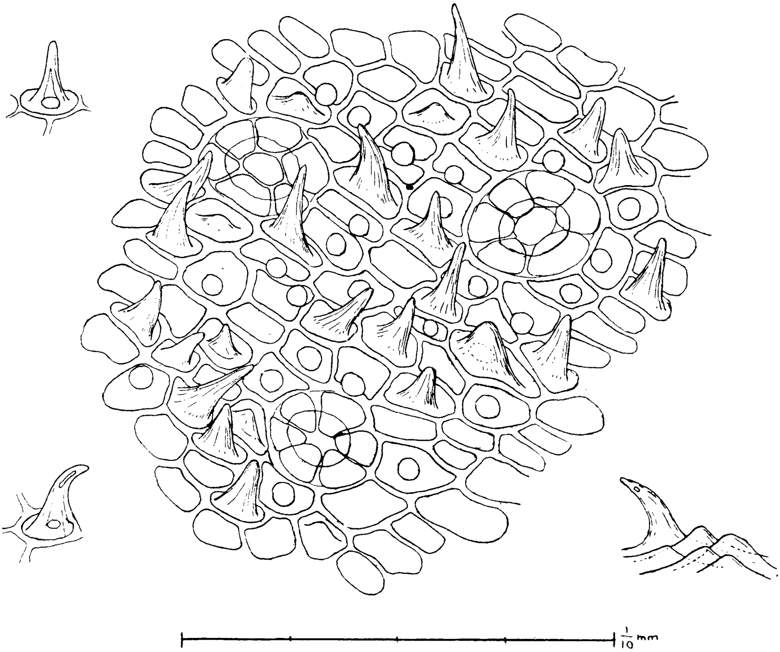

FIG. 1

one of the individual spines figured. The second and third single spines figured show irregular cavities toward the apex which are apparently cut off from the cell cavity, and the third spine figured gives a good idea of the papillose character of those adjacent cells in which these processes are not prominently developed.

In the area included in fig. 1 are three of the curious stomatal openings which apparently characterize the genus *Frenelopsis*. These are circular in outline and about 0.03 mm. in diameter. They are very numerous, but whether they are localized on certain portions of the branches which perform the functions of leaves in this genus, or whether they are uniformly distributed on the annual shoots, could not be determined. They consist of five or six guard cells arranged around the central stomatal opening. These cells are much thinner-walled than the epidermal cells. In form they are relatively slender distally and broad proximally. As viewed through the microscope, they are darker colored around the stomatal opening and peripherally they are lighter. Since structural material is not available, their exact attitude is made out with difficulty. Their outer centrally directed ends come into focus at about the same time as do the outer ends of the longer spinelike processes, or very soon after, while their inner broad ends are visible after the epidermal cells have gone out of focus; hence it is obvious that they are inclined toward each other and project outward for a considerable distance from beneath the surrounding epidermal cells. It is believed that fig. 2, which is a diagrammatical drawing of a single group of these guard cells and two adjacent epidermal cells viewed in a radial section of a twig, gives an accurate idea of their arrangement and proportions.

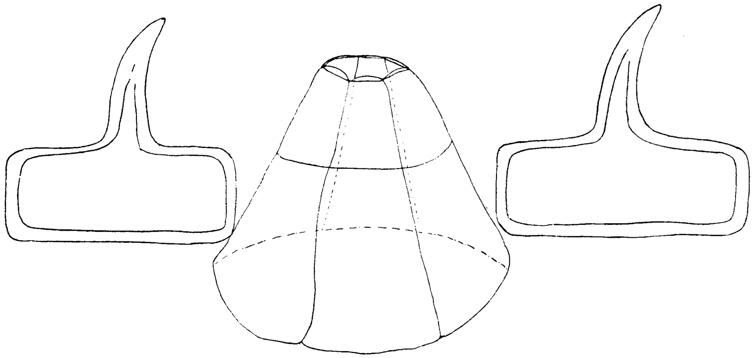

FIG. 2

In their more essential characters they agree with the stomata as described by ZEILLER for *F. Hoheneggeri* and by VELENOVSKY for *F. bohemica.* Just what were the physiological factors responsible for the great reduction of the leaves and the assumption of the photosynthetic processes by the branches in *Frenelopsis* it is difficult to imagine. Such features are usually associated with peculiarities of climate and habitat, and suggest strong insolation and lack of humidity; but such conditions are not suggested by the other members of the flora associated with *Frenelopsis,* since with the Potomac species are found large numbers of ferns, many of them apparently tree ferns with decompound fronds a meter or more across, and large numbers of cycads of various genera and large size; while in the latest beds in which *F. ramosissima* occurs there are considerable numbers of dicotyledonous leaves, some of which are allied with genera which in the modern flora are confined to tropical areas where the humidity is high and the rainfall heavy.

It is possible that these peculiar features in the cretaceous species of *Frenelopsis* were inherited from triassic ancestors which acquired them during those portions of the Triassic when the climate was extremely arid, as we know it was from physical as well as paleontological criteria. —EDWARD WILBER BERRY, *The Johns Hopkins University, Baltimore, Md.*